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IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Applicant: **Shuo-Yen Robert Li**

Case: **15**

Serial No. **09/882,139**

Filed: **June 15, 2001**

Group Art Unit:

Examiner:

Title of Invention: **A CONDITIONALLY NONBLOCKING SWITCH OF THE CIRCULAR EXPANDER TYPE**

THE COMMISSIONER OF PATENTS AND TRADEMARKS
WASHINGTON, D.C. 20231

SIR:

PRELIMINARY AMENDMENT

Enclosed is a Preliminary Amendment in the above-identified application. Please amend the application as follows.

In the Specification:

Replace pages 8 and 9 with the following:

-- SUMMARY OF THE INVENTION

The shortcomings of the prior art, as well as other limitations and deficiencies, are obviated in accordance with the present invention by applying algebraic principles to the physical realization of a large switching fabric based upon contemporary technologies.

In accordance with a broad method aspect of the present invention, a method for implementing a class of N×N circular expanders each serving a connection request to route m incoming signals, m≤N, and for enabling the service of any connection

request in a nonblocking way on the condition that the connection request is compliant to certain constraints, the method for each of the circular expanders includes: (a) configuring a switch defined by a set of connection states and having an array of N input ports with N distinct input addresses 0, 1, … , N−1 and an array of N output ports with N distinct output addresses 0, 1, … , N−1 wherein the m incoming signals arrive at m input ports determining m active input addresses and are destined for a total of n, $m \leq n \leq N$, distinct output ports determining n active output addresses, and wherein said constraints on the connection request are that: for any two active input addresses i and j and any two active output addresses p and q such that i is being connected to p and j is being connected to q, $\|i-j\|_N \leq |p-q|$, where $\|i-j\|_N = \min\{|i-j|, N-|i-j|\}$ is the distance between i and j on the discrete circle of length N; and (b) routing the incoming signals from said m input ports to said n distinct output ports by activating one of the connection states such that the activated one of the connection states accommodates the connection request subject to said constraints on the connection request, said class excluding (i) those having a switch constructed from the banyan network of expander cells prepended with the shuffle exchange and (ii) those having a switch constructed from the shuffle-exchange network of expander cells prepended with the shuffle exchange.

In accordance with a broad system aspect of the present invention, a class of N×N circular expanders each serving a connection request to route m incoming signals, $m \leq N$, and for enabling the service of any connection request in a nonblocking way on the condition that the connection request is compliant to certain constraints, each of the circular expanders includes: (a) a switch defined by a set of connection states and having

an array of N input ports with N distinct input addresses 0, 1, ... , N−1 and an array of N output ports with N distinct output addresses 0, 1, ... , N−1 wherein the m incoming signals arrive at m input ports determining m active input addresses and are destined for a total of n, $m \leq n \leq N$, distinct output ports determining n active output addresses, and wherein said constraints on the connection request are that: for any two active input addresses i and j and any two active output addresses p and q such that i is being connected to p and j is being connected to q, $\|i-j\|_N \leq |p-q|$, where $\|i-j\|_N = \min\{|i-j|, N-|i-j|\}$ is the distance between i and j on the discrete circle of length N; and (b) control circuitry, coupled to the switch, for routing the incoming signals from said m input ports to said n distinct output ports by activating one of the connection states such that the activated one of the connection states accommodates the connection request subject to said constraints on the connection request, said class excluding (i) those having a switch constructed from the banyan network of expander cells prepended with the shuffle exchange and (ii) those having a switch constructed from the shuffle-exchange network of expander cells prepended with the shuffle exchange.

Please replace lines 1-3 on page 13 as follows: --

FIG. 21B depicts a (1 2 3) permutation on an 8×8 exchange;

FIG. 21C depicts a (3 1) permutation on an 8×8 exchange;

FIG. 21D depicts a combined (1 4)(2 3) permutation on an 8×8 exchange;--.

Page 104, replace line 13 as follows: --$k \le N$, from k inputs (which are not necessarily distinct) to k distinct outputs subject to: there exists a rotation on the ordering of--.

Page 104, replace line 15 as follows: --(a) the k active input addresses (which are not necessarily distinct) are consecutive after the rotation; and--.

In the Claims:

Please cancel claims 1-21.

Please add claims 22-42 as follows:

--22. A method for implementing a class of $N \times N$ circular expanders each serving a connection request to route m incoming signals, $m \le N$, and for enabling the service of any connection request in a nonblocking way on the condition that the connection request is compliant to certain constraints, the method for each of the circular expanders comprising

configuring a switch defined by a set of connection states and having an array of N input ports with N distinct input addresses $0, 1, \ldots, N-1$ and an array of N output ports with N distinct output addresses $0, 1, \ldots, N-1$ wherein the m incoming signals arrive at m input ports determining m active input addresses and are destined for a total of n, $m \le n \le N$, distinct output ports determining n active output addresses, and wherein said constraints on the connection request are that: for any two active input addresses i and j and any two active output addresses p and q such that i is being connected to p and j is being connected to q, $\|i-j\|_N \le |p-q|$, where $\|i-j\|_N = \min\{|i-j|, N-|i-j|\}$ is the distance between i and j on the discrete circle of length N, and

routing the incoming signals from said m input ports to said n distinct output ports by activating one of the connection states such that the activated one of the connection states accommodates the connection request subject to said constraints on the connection request,

said class excluding (i) those having a switch constructed from the banyan network of expander cells prepended with the shuffle exchange and (ii) those having a switch constructed from the shuffle-exchange network of expander cells prepended with the shuffle exchange.

23. The method as recited in claim 22 wherein the configuring includes constructing the switch as an N×N k-stage switching network composed of k stages of nodes, an interstage exchange between any succeeding two of the k stages, an input exchange and an output exchange, and wherein each node is filled with another switch.

24. The method as recited in claim 22 wherein the configuring includes constructing the switch as an N×N k-stage switching network composed of k stages of nodes, an interstage exchange between any succeeding two of the k stages, an input exchange and an output exchange, and wherein each node is filled with an circular expander.

25. The method as recited in claim 22 wherein the configuring includes constructing the switch as a two-stage interconnection network composed of a first stage of nodes being the input nodes and a second stage of nodes being the output nodes, an interstage exchange, and an input exchange corresponding to the interstage exchange prepended to

the network, and wherein each node is filled with an circular expander.

26. The method as recited in claim 22 wherein the configuring includes constructing the switch as an X2 interconnection network having nodes and wherein each node is filled with an circular expander.

27. The method as recited in claim 22 wherein the configuring includes constructing the switch as an X2 interconnection network having nodes and wherein the nodes are filled with a plurality of circular expanders.

28. The method as recited in claim 22 wherein the configuring includes constructing the switch as a recursive X2 interconnection network having nodes and wherein each node is filled with an circular expander.

29. The method as recited in claim 22 wherein the configuring includes constructing the switch as a recursive X2 interconnection network having nodes and wherein the nodes are filled with a plurality of circular expanders.

30. The method as recited in claim 22 wherein the configuring includes constructing the switch as a recursive X2 interconnection network having nodes and wherein each of the nodes is a cell and each cell is filled with a $2{\times}2$ circular expander.

31. The method as recited in claim 30 wherein the $2{\times}2$ circular expander is an

expander cell.

32. The method as recited in claim 22 wherein the configuring includes constructing the switch as a recursive X2 interconnection network of cells with each cell filled with a 2×2 circular expander.

33. The method as recited in claim 32 wherein the 2×2 circular expander is an expander cell.

34. The method as recited in claim 22 wherein the configuring includes constructing the switch as a banyan-type network whose trace and guide are both monotonically increasing and wherein each of the 2×2 nodes of the banyan-type network is filled with a 2×2 circular expander.

35. The method as recited in claims from 34 wherein the 2×2 circular expander is an expander cell.

36. The method as recited in claim 22 wherein the configuring includes constructing the switch as a recursive plain 2-stage interconnection network of cells prepended with a swap exchange and wherein each cell of the network is filled with a 2×2 circular expander.

37. The method as recited in claim 36 wherein the 2×2 circular expander is an

expander cell.

38. The method as recited in claim 22 wherein the configuring includes constructing the switch as a divide-and-conquer network of cells prepended with a swap exchange and wherein each cell of the network is filled with a 2×2 circular expander

39. A class of N×N circular expanders each serving a connection request to route m incoming signals, $m \le N$, and for enabling the service of any connection request in a nonblocking way on the condition that the connection request is compliant to certain constraints, each of the circular expanders comprising

a switch defined by a set of connection states and having an array of N input ports with N distinct input addresses 0, 1, … , N−1 and an array of N output ports with N distinct output addresses 0, 1, … , N−1 wherein the m incoming signals arrive at m input ports determining m active input addresses and are destined for a total of n, $m \le n \le N$, distinct output ports determining n active output addresses, and wherein said constraints on the connection request are that: for any two active input addresses i and j and any two active output addresses p and q such that i is being connected to p and j is being connected to q, $\|i-j\|_N \le |p-q|$, where $\|i-j\|_N = \min\{|i-j|, N-|i-j|\}$ is the distance between i and j on the discrete circle of length N, and

control circuitry, coupled to the switch, for routing the incoming signals from said m input ports to said n distinct output ports by activating one of the connection states such that the activated one of the connection states accommodates the connection request subject to said constraints on the connection request,

said class excluding (i) those having a switch constructed from the banyan network of expander cells prepended with the shuffle exchange and (ii) those having a switch constructed from the shuffle-exchange network of expander cells prepended with the shuffle exchange.

40. The circular expander as recited in claim 39 wherein the switch is constructed by an $N \times N$ k-stage switching network composed of k stages of nodes, an interstage exchange between any succeeding two of the k stages, an input exchange and an output exchange, and wherein each node is filled with another switch.

41. The circular expander as recited in claim 39 wherein the switch is constructed by an $N \times N$ k-stage switching network composed of k stages of nodes, an interstage exchange between any succeeding two of the k stages, an input exchange and an output exchange, and wherein each node is filled with another circular expander.

42. The circular expander as recited in claim 39 wherein the switch is constructed from a two-stage interconnection network composed of a first stage of nodes being the input nodes and a second stage of nodes being the output nodes, an interstage exchange, and an input exchange corresponding to the interstage exchange prepended to the network, and wherein each node is filled with another circular expander.--.

REMARKS

All of the original claims 1-21 have been cancelled, and replaced with claims 22-42 to ensure that the Applicant sets forth with particularity what the Applicant regards as his invention.

Accordingly, substantially all of the Summary of Invention (pages 8 and 9) has been replaced to be commensurate with the newly-added claims.

Typographical errors on page 13 relating to Figure numbers have been amended to secure correspondence between the Figures and the specification.

Respectfully submitted,

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Date: 9-8-01

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

Page 13, line 1 has been amended as follows: --FIG. ~~22B~~ 21B depicts a (1 2 3) permutation on an 8×8 exchange;--

Page 13, line 2 has been amended as follows: --FIG. ~~22C~~ 21C depicts a (3 1) permutation on an 8×8 exchange;--

Page 13, line 3 has been amended as follows: --FIG. ~~22D~~ 21D depicts a combined (1 4)(2 3) permutation on an 8×8 exchange;--

Page 104, line 13 has been amended as follows: --$k \leq N$, from k inputs (which are not necessarily distinct) to k distinct outputs subject to: there exists a rotation on the ordering of--.

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